

What Is Claimed Is:

1. A wavelength division multiplexing transmission system for transmitting wavelength division multiplexing signals, where signal lights with different signal bandwidths are wavelength division-multiplexed, comprising at least one of a demultiplexing unit for demultiplexing said wavelength division multiplexing signals and a multiplexing unit for multiplexing a plurality of signal lights that are input, wherein said demultiplexing unit further comprises a plurality of output ports for outputting demultiplexed signal lights, and each output port has transmission characteristics to be set such that the bandwidth of the transmission band where light transmits and the bandwidth of the non-transmission band where light does not transmit are different, and said transmission band is substantially the same as the signal band of the signal lights that are output from said output port out of said received wavelength division multiplexing signals; and said multiplexing unit further comprises a plurality of input ports for inputting said plurality of signal lights, and filters and multiplexes the signal lights that are input from said plurality of input ports respectively based on the transmission characteristics of each input port, and each of said input ports has a transmission band which substantially matches with the

signal band of the signal lights to be input to said input port.

2. An optical receiver for receiving wavelength  
5 division multiplexing signals where signal lights with  
different signal bandwidths are wavelength-division  
multiplexed, comprising a demultiplexing unit for  
demultiplexing said wavelength division multiplexing signals  
and outputting the demultiplexed signal lights from a  
10 plurality of output ports, wherein  
each output port has transmission characteristics  
to be set such that the bandwidth of the transmission band  
where the light transmits and the bandwidth of the non-  
transmission band where the light does not transmit are  
15 different, and said transmission band substantially matches  
with the signal band of the signal lights that are output  
from said output port out of said received wavelength  
division multiplexing signals.

20 3. The optical receiver according to Claim 2, wherein  
said wavelength division multiplexing signals further  
comprises first signal light with transmission bandwidth F1  
and second signal lights with transmission bandwidth F2,  
which are arrayed alternately with the frequency interval F  
25  $(F \geq (F1 + F2)/2)$ , and

said demultiplexing unit is provided with an  
interleaver comprising:

an input port for inputting said first wavelength division multiplexing signals;

a first output port having a transmission band which substantially matches the signal band of said first  
5 signal light; and

a second output port having a transmission band which substantially matches with the signal band of said  
second signal light.

10 4. The optical receiver according to Claim 2, wherein  
said wavelength division multiplexing signal  
further comprises a first signal light with transmission  
bandwidth  $F_1$ , and a second signal light with transmission  
bandwidth  $F_2$ , which are arrayed alternately with the  
15 frequency interval  $F$  ( $F \geq (F_1 + F_2)/2$ ),

said demultiplexing unit further comprises:  
a first interleaver comprising a first port for  
inputting said wavelength division multiplexing signals and  
filtering and outputting said wavelength division  
20 multiplexing signals based on the transmission  
characteristics where the transmission band and the non-  
transmission band with the bandwidth  $2F$  are alternately  
repeated, and a second port for filtering and outputting  
said wavelength division multiplexing signals based on the  
25 opposite transmission characteristics from said first port;

a second interleaver further comprising a third  
port for inputting the signal lights from said first port

and filtering and outputting the signal lights from said first port based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are alternately repeated and a fourth port for  
5 filtering and outputting the signal lights from said first port based on the opposite transmission characteristics from said third port; and

a third interleaver further comprising a fifth  
port for inputting the signal lights from said second port  
10 and filtering and outputting the signal lights from said second port based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are alternately repeated, and a sixth port for  
filtering and outputting the signal lights from said second  
15 port based on the opposite transmission characteristics from said fifth port;  
wherein

the central frequency of the transmission bands of said first, second and third interleavers are shifted from  
20 the central frequency of the signal band of said first and second signal lights so that the overlapping portion of the transmission bands of said first and third ports include the signal band of said second signal light, the overlapping portion of the transmission bands of said first and fourth  
25 ports include the signal band of said first signal light, the overlapping portion of the transmission bands of said second and fifth ports include the signal band of said first

signal lights, and the overlapping portion of the transmission bands of said second and sixth ports include the signal bands of said second signal lights.

5           5.     The optical receiver according to Claim 4, wherein

              the central frequency of the transmission band of said first port shifts  $F1/2$  to the lower frequency side from the central frequency of the signal band of said second signal light, and

10           the central frequency of the transmission band of said third and fifth ports shifts  $F1/2$  to the higher frequency side from the central frequency of the signal band of said second signal light.

15           6.     The optical receiver according to Claim 4 or Claim 5, wherein said demultiplexing unit further comprises a demultiplexer for demultiplexing signal lights that are output from said third to sixth ports to signal lights with respective wavelengths.

20           7.     The optical receiver according to Claim 2, wherein

              said wavelength division multiplexing signals further comprises a first signal lights with transmission bandwidth  $F1$ , and a second signal lights with transmission bandwidth  $F2$ , which are arrayed alternately with the frequency interval  $F$  ( $F \geq (F1 + F2)/2$ ): and

              said demultiplexing unit further comprises:

a coupler for inputting said wavelength division multiplexing signals and outputting said wavelength division multiplexing signals through two ports;

a first interleaver further comprising a first  
5 port for inputting said wavelength division multiplexing signals from said coupler and filtering and outputting said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_1$ , of which the center is the central  
10 frequency of the signal band of said first signal lights, is repeated with the period  $4F$ , and a second port for filtering and outputting said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_1$ , which is shifted  
15 for the frequency  $2F$  from the transmission band of said first port, is repeated with the period  $4F$ ; and

a second interleaver further comprising a third  
port for inputting said wavelength division multiplexing signals from said coupler and filtering and outputting said  
20 wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_2$ , of which the center is the central frequency of the signal band of said second signal lights, is repeated with the period  $4F$ , and a fourth port for  
25 filtering and outputting said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the

bandwidth  $F_2$ , which is shifted for the frequency  $2F$  from the transmission band of said third port, is repeated with the period  $4F$ .

5        8.    The optical receiver according to Claim 7, wherein  
              said demultiplexing unit further comprises a  
demultiplexer for demultiplexing signal lights, that are  
output from said first to fourth ports, into signal lights  
with respective wavelengths.

10        9.    The optical receiver according to Claim 2, wherein  
              said wavelength division multiplexing signals  
              further comprises a first signal lights with transmission  
              bandwidth  $F_1$ , and a second signal lights with transmission  
15    bandwidth  $F_2$  which are arrayed alternately with the  
frequency interval  $F$  ( $F \geq (F_1 + F_2)/2$ ),

              said demultiplexing unit further comprises:  
              a coupler for inputting said wavelength division  
multiplexing signals and outputting said wavelength division  
20    multiplexing signals through two ports;  
              a first interleaver further comprising a first  
port for inputting said wavelength division multiplexing  
signals from said coupler and filtering and outputting said  
wavelength division multiplexing signals based on the  
25    transmission characteristics where the transmission band and  
the non-transmission band with the bandwidth  $F_2$  are  
alternately repeated, and a second port for filtering and



outputting said wavelength division multiplexing signals based on the opposite transmission characteristics from said first port;

5 a second interleaver further comprising a third port for inputting said wavelength division multiplexing signals from said coupler and filtering and outputting said wavelength division multiplexing signals based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are  
10 alternately repeated, and a fourth port for filtering and outputting said wavelength division multiplexing signals based on the opposite transmission characteristics from said third port; and

a first to fourth demultiplexers for inputting  
15 signal lights from said first to fourth ports respectively, filtering the signal lights from said first to fourth ports respectively, demultiplexing the signal lights into signal lights with respective wavelengths and outputting them based on the transmission characteristics where the transmission  
20 band and the non-transmission band with the bandwidth  $2F$  are alternately repeated, wherein

the central frequency of the transmission bands of said first and second interleavers and said first to fourth demultiplexers is shifted from the central frequency of said  
25 first and second signal lights so that the overlapping portion of the transmission bands of said first port and said first demultiplexer and the overlapping portion of the



transmission bands of said second port and said second demultiplexer include the signal band of said first signal lights, and the overlapping portion of the transmission bands of said third port and said third demultiplexer and the overlapping portion of the transmission bands of said fourth port and said fourth demultiplexer include the signal band of said second signal lights.

10. The optical receiver according to Claim 9, wherein the central frequency of the transmission band of said first port shifts  $3 \times F1/2$  to the higher frequency side from the central frequency of the signal band of said first signal light,

the central frequency of the transmission band of said first and second demultiplexers shifts  $3 \times F1/2$  to the lower frequency side from the central frequency of the signal band of said first signal light,

the central frequency of the transmission band of said third port shifts  $F1/2$  to the lower frequency side from the central frequency of the signal band of said second signal light, and

the central frequency of the transmission band of said third and fourth demultiplexers shifts  $F1/2$  to the higher frequency side from the central frequency of the signal band of said second signal light.

11. The optical receiver according to Claim 2, wherein

said wavelength division multiplexing signal further comprises a first signal lights with transmission bandwidth  $F_1$  and second signal lights with transmission bandwidth  $F_2$ , which are arrayed alternately with the  
5 frequency interval  $F$  ( $F \geq (F_1 + F_2)/2$ ), and

said demultiplexing unit further comprises:

a coupler for inputting said wavelength division multiplexing signals and outputting said wavelength division multiplexing signals through two ports;

10 a demultiplexer for inputting said wavelength division multiplexing signals from said coupler, filtering said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_1$ , of which the center is the central  
15 frequency of the signal band of said first signal lights, is repeated with the period  $2F$ , demultiplexing the signals into signal lights with respective wavelengths, and outputting them; and

an interleaver further comprising a first port for  
20 inputting said wavelength division multiplexing signals from said coupler, and filtering and outputting said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_2$ , of which the center is the central frequency  
25 of the signal band of said second signal lights, is repeated with the period  $4F$ , and a second port for filtering and outputting said wavelength division multiplexing signals

based on the transmission characteristics where the transmission band with the bandwidth  $F_2$ , which is shifted for the frequency  $2F$  from the transmission band of said first port, is repeated with the period  $4F$ .

5

12. The optical receiver according to Claim 11, wherein said demultiplexer further comprises a first and second demultiplexers for inputting signal lights from said first and second ports of said interleaver respectively, demultiplexing the signal lights that are input to signal lights with respective wavelengths, and outputting them.

13. The optical receiver according to Claim 2, wherein said wavelength division multiplexing signal further comprises a first signal lights with transmission bandwidth  $F_1$  and second signal lights with transmission bandwidth  $F_2$ , which are arrayed alternately with the frequency interval  $F$  ( $F \geq (F_1 + F_2)/2$ ), and said demultiplexing unit further comprises:  
a coupler for inputting said wavelength division multiplexing signals and outputting said wavelength division multiplexing signals through two ports;

a first demultiplexer for inputting said wavelength division multiplexing signals from said coupler, filtering said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_1$ , of which the center

is the central frequency of the signal band of said first signal lights, is repeated with the period  $2F$ , demultiplexing the signals into signal lights with respective wavelengths, and outputting them; and

5           a second demultiplexer for inputting said wavelength division multiplexing signals from said coupler, filtering said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_2$ , of which the center is the central frequency of the signal band of said second signal lights, is repeated with the period  $2F$ , and demultiplexing the signals into signal lights with respective wavelengths, and outputting them.

15           14. The optical receiver according to Claim 2, wherein said wavelength division multiplexing signals further comprises a first signal light group of three first signal lights with transmission bandwidth  $F_1$  arrayed next to each other with frequency interval  $F_1$ , and one second signal light with transmission bandwidth  $F_2$  ( $F_2 \leq F$ ) positioned at a position of frequency interval  $F$  ( $F = 3 \times F_1$ ) from the central frequency of the first signal light positioned at the center of said first signal light group, which are alternately arrayed, and

25           said demultiplexing unit further comprises:  
a first interleaver further comprising a first port for inputting said wavelength division multiplexing

signals and filtering and outputting said wavelength  
division multiplexing signals based on the transmission  
characteristics where the transmission band with the  
bandwidth  $F$ , of which the center is the central frequency of  
5 the first signal light positioned at the center of said  
first signal light group, and the non-transmission band with  
the bandwidth  $F$  are alternately repeated, and a second port  
for filtering and outputting said wavelength division  
multiplexing signals based on the opposite transmission  
10 characteristics from said first port; and a second interleaver further comprising a third  
port for inputting signal lights from said first port and  
filtering and outputting the signal lights from said first  
port based on the transmission characteristics where the  
15 transmission band with the bandwidth  $F_1$ , of which the center  
is the central frequency of the first signal light  
positioned at the edge of said first signal light group, and  
the non-transmission band with the bandwidth  $F_1$  are  
alternately repeated, and a fourth port for filtering and  
20 outputting the signal lights from said first port based on  
the opposite transmission characteristics from said third  
port.

15. The optical receiver according to Claim 14,  
25 wherein said demultiplexing unit further comprises a first,  
second and third demultiplexers for inputting signal lights  
to be output from said second, third and fourth ports

respectively, and demultiplexing the signal lights that are input to signal lights with respective wavelengths.

16. The optical receiver according to Claim 2, wherein
- 5       said wavelength division multiplexing signals further comprises a first signal light group of three first signal lights with transmission bandwidth  $F_1$  arrayed next to each other with frequency interval  $F_1$ , and one second signal light with transmission bandwidth  $F_2$  ( $F_2 \leq F_1$ ) positioned at
- 10   a position of frequency interval  $F$  ( $F = 3 \times F_1$ ) from the central frequency of the first signal light positioned at the center of said first signal light group, which are alternately arrayed; and
- said demultiplexing unit further comprises:
- 15       a coupler for inputting said wavelength division multiplexing signals and outputting said wavelength division multiplexing signals through two ports;
- a first interleaver further comprising a first port for inputting said wavelength division multiplexing signals
- 20   from said coupler and filtering and outputting said wavelength division multiplexing signals based on the transmission characteristics where the transmission band with the bandwidth  $F_1$ , of which the center is the central frequency of the first signal lights positioned at the edge
- 25   of said first signal lights and the non-transmission band with the bandwidth  $F_1$ , are alternately repeated, and a second port for filtering and outputting said wavelength

division multiplexing signals based on the opposite transmission characteristics from said first port; and

a second interleaver further comprising at least a third port for inputting said wavelength division

5 multiplexing signals from said coupler, and filtering and outputting said wavelength division multiplexing signals based on the transmission characteristics where the transmission band of the bandwidth  $F$ , of which the center is the central frequency of the second signal lights and the non-transmission band with the bandwidth  $F$  are alternately repeated.

17. The optical receiver according to Claim 16, wherein said demultiplexing unit further comprises a first, 15 second and third demultiplexers for inputting signal lights to be output from said first, second and third ports respectively, and demultiplexing the signal lights that are input to signal lights with respective wavelengths.

20 18. An optical transmitter for wavelength division multiplexing and transmitting a plurality of signal lights with a different signal bandwidth, comprising

a multiplexing unit that further comprises a plurality of input ports for inputting said plurality of 25 signal lights, and that filters and multiplexes the signal lights which are input from said plurality of input ports respectively based on the transmission characteristics of



each port, wherein

each input port of said multiplexing unit has a transmission band which substantially matches with the signal band of the signal lights to be input to said input  
5 port.

19. The optical transmitter according to Claim 18,

wherein said plurality of signal lights comprises:

a first signal light group consisting of a  
10 plurality of signal lights each having a transmission  
bandwidth  $F_1$  and being arrayed with the frequency interval  
 $4F$ ;

a second signal light group consisting of a  
plurality of signal lights each having transmission  
15 bandwidth  $F_2$  and being arrayed at the positions at frequency  
interval  $F$  ( $F \geq (F_1 + F_2)/2$ ) from the central frequency of  
each signal light constituting said first signal light  
group;

a third signal light group consisting of a  
20 plurality of signal lights each having transmission  
bandwidth  $F_1$  and being arrayed at the positions at frequency  
interval  $2F$  from the central frequency of each signal light  
constituting said first signal light group; and

a fourth signal light group consisting of a  
25 plurality of signal lights each having said transmission  
bandwidth  $F_2$  and being arrayed at positions at frequency  
interval  $2F$  from the frequency of each signal light

constituting said second signal light group,

said multiplexing unit further comprises:

a first interleaver which further comprises a first port for inputting said first signal light group with the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $F$  are alternately repeated, and a second port for inputting said second signal light group with the opposite transmission characteristics from said first port, and multiplexes and outputs said first and second signal light groups which were input to said first and second ports respectively;

a second interleaver which further comprises a third port for inputting said third signal light group with the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $F$  are alternately repeated, and a fourth port for inputting said fourth signal light group with the opposite transmission characteristics from said third port, and multiplexes and outputs said third and fourth signal light groups which were input to said third and fourth ports; and

a third interleaver which further comprises a fifth port for inputting signal lights from said first interleaver with the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $F$  are alternately repeated, and a sixth port for inputting signal lights from said second interleaver with the opposite transmission characteristics from said fifth

port, and multiplexes and outputs the signal lights which were input to said fifth and sixth ports, and

wherein the central frequency of the transmission bands of said first, second and third interleavers are shifted from the central frequency of each signal light of said first and second signal light groups so that the overlapping portion of the transmission bands of said first and fifth ports include the signal band of each signal light of said first signal light group, the overlapping portion of the transmission bands of said second and fifth ports include the signal band of each signal light of said second signal group, the overlapping portion of the transmission bands of said third and sixth ports include the signal band of each signal light of said third signal light group, and the overlapping portion of the transmission bands of said fourth and sixth ports include the signal band of each signal light of said fourth signal light group.

20. The optical transmitter according to Claim 19, wherein

the central frequency of the transmission band of said first and fourth ports shift  $F1/2$  to the higher frequency side from the central frequency of each signal light of said second signal light group, and the central frequency of the transmission band of said fifth port shifts  $F1/2$  to the lower frequency side from the central frequency of the signal band of each signal

light of said second signal light group.

21. The optical transmitter according to Claim 19 or Claim 20, wherein

5           said multiplexing unit further comprises:

          a first multiplexer for multiplexing each signal  
light of said first signal light group, generating said  
first signal light group and inputting the same to said  
first port;

10           a second multiplexer for multiplexing each signal  
light of said second signal light group, generating said  
second signal light group, and inputting the same to said  
second port;

          a third multiplexer for multiplexing each signal  
15 light of said third signal light group, generating said  
third signal light group, and inputting the same to said  
third port; and

          a fourth multiplexer for multiplexing each signal  
light of said fourth signal light group, generating said  
20 fourth signal light group, and inputting the same to said  
fourth port.

22. The optical transmitter according to Claim 18,  
wherein

25           said plurality of signal light further comprises:

          a first signal light group consisting of a  
plurality of signal lights each having a transmission

bandwidth  $F_1$  and being arrayed with the frequency interval  $4F$ ;

5 a second light group consisting of a plurality of signal lights each having transmission bandwidth  $F_1$  and being arrayed at the position at frequency interval  $2F$  from the central frequency of each signal light constituting said first signal light group;

10 a third signal light group consisting of a plurality of signal lights each having transmission bandwidth  $F_2$  and being arrayed at the position at frequency interval  $F$  ( $F \geq (F_1 + F_2)/2$ ) from the central frequency of each signal light constituting said first signal light group; and

15 a fourth signal light group consisting of a plurality of signal lights each having said transmission band  $F_2$  and being arrayed at positions at frequency interval  $2F$  from the frequency of each signal light constituting said third signal light group, and

wherein the optical transmitter further comprises:

20 a first interleaver which further comprises a first port for inputting said first signal light group and filtering and outputting said first signal light group based on the transmission characteristics which have the transmission band with bandwidth  $F_1$ , of which the center is  
25 the central frequency of the signal band of each signal light of said first signal light group, and a second port for inputting said second signal light group and filtering

and outputting said third signal light group based on the transmission characteristics which have the transmission band with bandwidth  $F_1$ , which is shifted for frequency  $2F$  from the transmission band of said first port, multiplexes  
5 said filtered first and second signal light groups, and outputs the same;

a second interleaver which further comprises a third port for inputting said third signal light group and filtering and outputting said third signal light group based  
10 on the transmission characteristics which have the transmission band of bandwidth  $F_2$ , of which the center is the central frequency of the signal band of each signal light of said third signal light group; and a fourth port for inputting said fourth signal light group and filtering  
15 and outputting said fourth signal light group based on the transmission characteristics which have the transmission band with the bandwidth  $F_2$ , which is shifted for frequency  $2F$  from the transmission band of said third port, multiplexes said filtered third and fourth signal light  
20 groups, and outputs the same; and

a coupler for multiplexing the signal groups from said first and second interleavers, and outputting the same.

23. The optical transmitter according to Claim 22,  
25 wherein

said multiplexing unit further comprises:

a first multiplexer for multiplexing each signal

light of said first signal light group, generating said first signal light group and inputting the same to said first port;

5 a second multiplexer for multiplexing each signal light of said second signal light group, generating said second signal light group, and inputting the same to said second port;

10 a third multiplexer for multiplexing each signal light of said third signal light group, generating said third signal light group, and inputting the same to said third port; and

15 a fourth multiplexer for multiplexing each signal light of said fourth signal light group, generating said fourth signal light group, and inputting the same to said fourth port.

24. The optical transmitter according to Claim 18, wherein

20 said multiplexing unit further comprises:  
a first multiplexer having a transmission bandwidth  $F_1$ , for inputting a plurality of signal lights arrayed with frequency interval  $4F$ , filtering said plurality of signal lights which were input based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are alternately  
25 repeated, multiplexing the signals into a first signal light group, and outputting the same;



a second multiplexer having transmission bandwidth  $F_1$  for inputting a plurality of signal lights arrayed at the position at the frequency interval  $2F$  from the central frequency of each signal light of said first signal light group, filtering said plurality of signal lights which were input based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are alternately repeated, multiplexing the signals into a second signal light group, and outputting the same;

a third multiplexer having transmission bandwidth  $F_2$ , inputting a plurality of signal lights arrayed at the position at the frequency interval  $F$  ( $F \geq (F_1 + F_2)/2$ ) from the central frequency of each signal light of said first signal light group, filtering said plurality of signal lights which were input based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are alternately repeated, multiplexing the signals into a third signal light group, and outputting the same;

a fourth multiplexing unit having a transmission bandwidth  $F_2$ , for inputting a plurality of signal lights arrayed at the position of the frequency interval  $2F$  from the central frequency of each signal light of said third signal light group, filtering said plurality of signal lights which were input based on the transmission characteristics where the transmission band and the non-

transmission band with the bandwidth  $2F$  are alternately repeated, multiplexing the signals into a fourth signal light group, and outputting the same;

a first interleaver which further comprises a  
5 first port for filtering said first signal light group from said first multiplexer based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are alternately repeated, and a second port for filtering said second signal  
10 light group from said second multiplexer based on the opposite transmission characteristics from said first port, and multiplexes and outputs said filtered first and second signal light groups;

a second interleaver which further comprises a  
15 third port for filtering said third signal light group from said third multiplexer based on the transmission characteristics where the transmission band and the non-transmission band with the bandwidth  $2F$  are alternately repeated, and a fourth port for filtering said fourth signal  
20 light group from said fourth multiplexer based on the opposite transmission characteristics from said third port, and multiplexes and outputs said filtered second and fourth signal light groups; and

a coupler for multiplexing signal light groups  
25 from said first and second interleavers, and outputting the same, and

wherein the central frequencies of the

transmission bands of said first and second interleavers and  
said first to fourth demultiplexers are shifted from the  
central frequency of said first and second signal light  
groups, so that the overlapping portion of the transmission  
5 bands of said first port and said first demultiplexer and  
the overlapping portion of the transmission bands of said  
second port and said second demultiplexer include the signal  
band of each signal light of said first signal light group,  
and the overlapping portion of said third port and said  
10 third demultiplexer, and the overlapping portion of the  
transmission characteristics of said fourth port and said  
fourth demultiplexer include the signal band of each signal  
light of said second signal lights.

15 25. The optical transmitter according to Claim 23,  
wherein

the central frequency of the transmission band of  
said first port shifts  $3 \times F1/2$  to the higher frequency side  
from the central frequency of each signal lights of said  
20 first signal light group,

the central frequency of the transmission band of  
said first and second multiplexers shifts  $3 \times F1/2$  to the  
lower frequency side from the central frequency of each  
signal light of said first signal light group,

25 the central frequency of the transmission band of  
said third port shifts  $F1/2$  to the lower frequency side from  
the central frequency of each signal light of said third

signal light group, and

the central frequency of the transmission band of  
said third and fourth multiplexers shifts  $F_1/2$  to the higher  
frequency side from the central frequency of each signal  
5 lights of said third signal light group.

26. The optical transmitter according to Claim 18,  
wherein

said multiplexing unit further comprises:

10 a multiplexer for inputting a plurality of first  
signal lights having the transmission bandwidth  $F_1$  with the  
frequency interval  $2F$  ( $F > F_1$ ), filtering said plurality of  
first signal lights based on the transmission  
characteristics having the transmission band with the  
15 bandwidth  $F_1$ , of which the center is each central frequency  
of said plurality of first signal lights, and multiplexing  
the signals into a first signal light group, and outputting  
the same;

an interleaver which further comprises a first  
20 port for inputting a second signal light group, where a  
plurality of second signal lights with the transmission  
bandwidth  $F_2$  are arrayed at positions at the frequency  
interval  $F$  ( $F \geq (F_1 + F_2)/2$ ) from the central frequency of  
every other signal band of said first signal light group,  
25 and filtering said second light signal group based on the  
transmission characteristics having the transmission band  
with the bandwidth  $F_2$ , of which the center is the central

frequency of each signal band of said second signal light group, and a second port for inputting a third signal light group, where a plurality of third signal lights with the transmission bandwidth  $F_2$  are arrayed at positions at the  
5 frequency interval  $F$  from the central frequency of every other signal band, which is different from said every other signal band, of said first signal light group, and filtering said third signal light group based on the transmission characteristics having the transmission band with the  
10 bandwidth  $F_2$ , of which the center is the central frequency of each signal band of said third signal light group, and multiplexes and outputs said second and third signal light groups after filtering; and

a coupler for multiplexing the signal lights from  
15 said multiplexer and said interleaver, and outputting the same.

27. The optical transmitter according to Claim 25,  
wherein

20 said multiplexing unit further comprises:

a first multiplexer for inputting said plurality of second signal lights at positions of the frequency interval  $F$  from the central frequency at every other signal band of said first signal lights group with frequency  
25 interval  $4F$ , multiplexing said plurality of second signal lights which were input, and outputting the same to said first port; and

a second multiplexer for inputting said plurality of third signal lights at positions at the frequency interval  $F$  from the central frequency of every other signal band, which is different from said every other signal band, of said first signal light group with frequency interval  $4F$ , multiplexing said plurality of second signal lights which were input, and outputting the same to said second port.

28. The optical transmitter according to Claim 18,  
10 wherein

said multiplexing unit further comprises:  
a first multiplexer for inputting a plurality of first signal lights having the transmission bandwidth  $F_1$  with frequency interval  $2F$  ( $F > F_1$ ), filtering said plurality of first signal lights based on the transmission characteristics having the transmission band with the bandwidth  $F_1$ , of which the center is each central frequency of said plurality of first signal lights, multiplexing the signals into a first signal light group, and outputting the same;  
20 same;

a second multiplexer for inputting a plurality of second signal lights with the transmission bandwidth  $F_2$  ( $F \geq (F_1 + F_2)/2$ ) at the frequency positions which is shifted for frequency  $F$  from each central frequency of said plurality of first signal lights, filtering said plurality of second signal lights based on the transmission characteristics having the transmission band with the bandwidth  $F_2$ , of which

the center is each central frequency of said plurality of second signal lights, multiplexing the signals into a second signal light group, and outputting the same; and

a coupler for multiplexing the signal lights from  
5 said first and second multiplexers, and outputting the same.

29. The optical transmitter according to Claim 18,  
wherein

said multiplexing unit further comprises a first  
10 interleaver comprising:

a first port for inputting a first signal light group where a plurality of sets of three first signal lights with transmission bandwidth  $F_1$ , which are arrayed adjacent to each other with the frequency interval  $F_1$ , are arrayed  
15 with the frequency interval  $6 \times F_1$ , and filtering said first signal light group based on the transmission characteristics having the transmission band with the bandwidth  $3 \times F_1$ , of which the center is the central frequency of the first signal light positioned at the center of each set of said  
20 first signal light group; and

a second port for inputting a second signal light group which is comprised of a plurality of second signal lights with the transmission bandwidth  $F_2$  ( $F_2 \leq 3 \times F_1$ ), of which the center is the frequency shifted for the frequency  
25  $3 \times F_1$  from the central frequency of the first signal light positioned at the center of each set of said first signal light group, and filtering said second signal light group



based on the opposite transmission characteristics from said first port, and

whrein said first interleaver multiplexes said first and second signal light groups after filtering, and  
5 outputs the same.

30. The optical transmitter according to Claim 28, wherein

said multiplexing unit further comprises a second  
10 interleaver comprising:  
a third port for inputting a third signal light group which is comprised of first signal lights at both ends of each set of said first signal light group, and filtering said third signal light group based on the transmission  
15 characteristics where the transmission band with the bandwidth  $F1$ , of which the center is the central frequency of the first signal light at one of said both ends and the non-transmission band with the bandwidth  $F1$ , which is adjacent thereto are alternately repeated; and  
20 a fourth port for inputting a fourth signal light group which is comprised of first signal lights at the center of each set of said first signal light group, and filtering said fourth signal group based on the opposite transmission characteristics from said third port, and  
25 wherein said second interleaver multiplexes said third and fourth signal light groups after filtering, and outputs the same.

31. The optical transmitter according to Claim 18,  
wherein

said multiplexing unit further comprises:

5 a first interleaver which comprises a first port  
for inputting a third signal light group which is comprised  
of first signal lights at both ends of each set out of the  
first signal group where a plurality of sets of three first  
signal lights with the transmission bandwidth  $F1$  which are  
10 arrayed adjacent to each other with frequency interval  $F1$ ,  
are arrayed with the frequency interval  $6 \times F1$ , and  
filtering said third signal light group based on the  
transmission characteristics having the transmission band  
with the bandwidth  $F1$ , of which the center is the central  
15 frequency of the first signal light at one of said both ends  
and the non-transmission band with the bandwidth  $F1$  which is  
adjacent thereto are alternately repeated, and a second port  
for inputting a fourth signal light group which is comprised  
of first signal lights at the center of each set of said  
20 first signal light group, for filtering said fourth signal  
group based on the opposite transmission characteristics  
from said first port, multiplexes said third and fourth  
signal light groups after filtering, and outputs the same;

a second interleaver for inputting a second signal  
25 light group which is comprised of a plurality of second  
signal lights with the transmission bandwidth  $F2$  ( $F2 \leq 3 \times F1$ ), of which the center is the frequency shifted for

frequency  $3 \times F1$  from the central frequency of the first signal light positioned at the center of each set of said first signal light group, and filtering and outputting said second signal light group based on the transmission

5 characteristics where the transmission band with the bandwidth  $F2$ , of which the center is the central frequency of each second signal light, and the non-transmission band with bandwidth  $F2$  adjacent thereto, are alternately repeated; and

10 a coupler for multiplexing the signal light groups from said first and second interleavers;